17 September 2002

CEERD-RN

Ms. Stephanie Lindloff
River Restoration Coordinator
Dam Bureau
NH Department of Environmental Services
6 Hazen Drive
PO Box 95
Concord, NH 03302-0095

Dear Ms. Lindloff:

Thank you for the opportunity to comment on potential ice impacts resulting from the proposed removal of the Wiswall Dam on the Lamprey River in Newmarket (No. 71.04), the Merrimack Village Dam on the Souhegan River in Merrimack (No. 156.01), the Winnicut River Dam on the Winnicut River in Greenland (No. 99.01), and the Melvin River Dam on the Melvin River in Melvin Village (No. 239.01). General comments relating to dam removal in ice-affected rivers is presented below. Specific comments relating to each of these rivers follows.

General Comments. Review of accumulated freezing degree day (AFDD) data for three National Weather Service stations in New Hampshire (Concord, Lebanon, and Pease AFB) indicates that average annual AFDD is greater than 800 °F days (Figure 1). Since ice covers are expected to form at AFDD greater than about 100 °F days, the Lamprey, Souhegan, Winnicut, and Melvin Rivers and their tributaries would be expected to form seasonal ice covers annually. Thus, ice impacts due to dam removal should be considered in dam removal plans for these rivers. ASCE (1997) provides guidelines for studies to be undertaken when considering removal of a dam, but do not address the potential impacts of dam removal on ice regime. Additional guidelines for dam removal in ice-affected rivers may be found in White and Moore (2002). In order to identify the likelihood of adverse impacts occurring, we recommend the following additional steps be taken for ice-affected rivers:

1. Characterize the existing ice regime, including formation, growth, breakup, transport, and jamming in the reaches upstream and downstream from the dam. Information on local ice processes may be found in the CRREL Ice Jam Database (http://www.crrel.usace.army.mil/ierd/icejam/icejam.htm) or USGS records. White and Zufelt (1994) provide suggestions for designing and carrying out an ice data collection program. At least one winter of ice monitoring should be performed, and preferably, more so that seasonal

variation in climatic and hydrologic conditions may be considered. Studying the ice regime for five or more winter seasons could provide the smallest statistical sample from which reasonably reliable projections may be made. However, often the time period between conceiving of a dam removal and its execution is on the order of one to two years, so ice data collection should be started as soon as a dam has been identified as a candidate for removal.

2. Characterize the ice regime that existed prior to dam construction. This will involve a search of historic records. Again, USGS records and the CRREL Ice Jam Database may contain information useful in characterizing the historic ice regime. A detailed search of local sources should supplement these records.

3. Hydraulic modeling of the ice conditions should be performed if jams are known to occur near the dam, both with and without the dam in place, to determine whether dam removal will affect the hydraulic conditions leading to jam formation. Both freeze up and breakup conditions should be considered. The reliability of the model results will depend on sufficient and reliable information for model calibration and verification, underlining the need for ice data collection. If the modeling indicates that the jam location will change, or severity will increase, ice mitigation measures should be considered. Summaries of applicable ice mitigation techniques may be found in Tuthill (1995) and Haehnel (1998).

4. Sediment management alternatives that include riverbed or bank erosion or sediment stabilization should include hydraulic modeling of ice conditions to identify areas of ice-induced scour and erosion. Proposed bank stabilization measures should be designed to resist ice impacts and ice-induced scour.

5. Dam removal will result in erosion and transport of the impounded sediments during both open-water and ice-affected conditions until an equilibrium state is reached. Hydraulic modeling of ice conditions should be performed to identify areas of ice-induced scour and erosion in the event that the timing or quantity of sediment movement could potentially be detrimental to the aquatic ecosystem.

6. Without at least one season of ice observations, it is difficult to characterize the ice regime at a particular site. However, in the case of each of these four dams there may be historical records detailing the ice regime at the dam due to their long history as industrial resources. The ice regime on similar rivers in New Hampshire can be described as follows: periods of intense cold in early winter result in the formation of frazil ice and the growth of sheet ice along the river's border. The frazil ice is transported downstream to some

location where the transport capacity of the river is exceeded, at which point it begins to deposit. This generally occurs at the upstream end of a dam impoundment where there is a sudden slope change from steep to mild. As cold temperatures continue, an ice cover made up of sheet ice and frazil ice will form in all but extremely turbulent reaches of river. This ice cover will break up mechanically as a result of sudden large increases in flow, or it can simply melt in place. Mechanical breakup in New Hampshire rivers usually requires a combination of precipitation and snowmelt. Mechanical breakup can result in the formation of ice jams if the transport of the broken ice is slowed or stopped. This often occurs at the upstream end of an impoundment, where the ice cover has been thickened by frazil deposition and is more resistant to breakup.

7. Following dam removal, frazil ice that may have collected in the dam impoundment will be transported downstream and is likely to deposit in downstream impoundments. Increased frazil deposition in these impoundments could affect the existing ice breakup and transport regime, resulting in increased jams at these dams. It is not possible to estimate the potential for increased frequency and/or severity of downstream ice jams without further study (see item 3 above).

<u>Wiswall Dam, Lamprey River, No. 71.04.</u> The Wiswall Dam, also called Packer's Falls Dam, was built about 1911 and is about 18 ft high and 200 ft long, with a surface area of 30 ac and estimated storage capacity of 360 ac-ft at normal spillway. A search of the CRREL Ice Jam Database (attached) revealed that three ice jams have been reported on the Lamprey River. One of these jams was located upstream from the Wiswall Dam in Epping, and two were reported at the USGS gage (01073500) in Newmarket, downstream from the Wiswall Dam (see Attachment 1). A detailed search of historical records has not been made and it is possible that information exists that could document ice jams at the Wiswall Dam both before and during the dam's existence. It is possible that jams form on the Lamprey River in the vicinity of the dam but have been below perception stage, that is, they have not been severe enough to warrant reporting. Relatively poor access to the river upstream from the dam could also result in under-reporting of ice jams. The jams at the USGS gage were reported as being caused by backwater from ice, indicating that the jams occurred downstream from the gage, probably upstream from Packer's Falls. Removal of the Wiswall Dam could change the frequency or severity of jams downstream from the dam. Observation of the ice regime at the Wiswall Dam and the downstream reach is *highly recommended* before removal in order to assess the potential for increased downstream jamming. It is also recommended that a search of historical records be made to determine whether the removal of the dam will impact the ice regime significantly.

Merrimack Village Dam, Souhegan River, No. 156.01. The Merrimack Village Dam was built in about 1911 and is about 20.5 ft high and 180 ft long, with a surface area of 12 ac and estimated storage capacity of 85 ac-ft at normal spillway. A search of the CRREL Ice Jam Database (attached) revealed that five ice jams have been reported on the Souhegan River. Ice jams have also been reported on Baboosic Brook and the Merrimack River in Merrimack, indicating an active ice regime, so that it is highly likely that more jams have occurred than have been reported. Three of the ice jams on the Souhegan River were located in Merrimack, one upstream from the USGS gage (01094000), and two reported at the gage (see Attachment 2). The jam upstream from the gage was apparently formed at an oxbow in the river about 1.5 miles upstream from the Everett Turnpike, while the jams at the gage were reported as being due to ice jams at the gage. These ice jams formed somewhere in the reach between the Merrimack Village Dam and the gage, most likely at the upstream end of the impoundment. It is possible that removal of the dam could change the ice regime of the river so that ice that might have jammed at the upstream end of the impoundment is transported downstream, where it could jam in the backwater from the Merrimack River. Observation of the ice regime at the Merrimack Village Dam and the downstream reach, including the adjacent Merrimack River, is *highly recommended* before removal in order to assess the potential for increased downstream jamming.

Winnicut River Dam, Winnicut River, No. 99.01. The Winnicut River Dam is about 14 ft high and 100 ft long, with a surface area of 20 ac and estimated storage capacity of 100 ac-ft at normal spillway. A search of the CRREL Ice Jam Database revealed no knowledge of ice jams occurring on the Winnicut River. However, a detailed search of historical records has not been made and it is possible that information exists that could document ice jams at the site both before and during the dam's existence. In addition, several jams are known to have formed on the nearby Lamprey River in Newmarket and Epping, and one jam is reported on the Salmon Falls River. The Winnicut Dam is listed in the National Inventory of Dams as having been built in 1959, but is shown on the 1893 USGS quadrangle. The dam appears to be located near the head of tide. If this is the case, removal of the dam may result in freezeup jam formation at or near the head of tide, similar to the after-effects of the Edwards Dam removal on the Kennebec River in Augusta, Maine.

Melvin River Dam, Melvin River, No. 239.01. The Melvin River Dam is about 16.5 ft high and 150 ft long, with a surface area of 11 ac and estimated storage capacity of 30 ac-ft at normal spillway. A search of the CRREL Ice Jam Database (attached) revealed that no ice jams have been reported on the Melvin River. The Melvin Village Dam is located on the river upstream from its confluence with Lake Winnipesaukee at Melvin Bay. Ice jams typically form at river/lake confluences, so it is possible that the presence of the dam has mitigated ice jam formation at the confluence. Since a detailed search of historical records has not been made, it is possible that information exists that could document ice jams at the site both before and during the dam's existence. It is *highly recommended* that a search of historical records be made in association with at least one winter's observation of the ice regime in order to be sure that enough information is available to make a determination about whether the removal of the dam will impact the ice regime significantly.

Please do not hesitate to contact me if you have any questions or would like further information.

Sincerely,

Kathleen D. White PhD, PE
Research Hydraulic Engineer

CF Mike Sheehan, CENAE-R-PT
Richard Carlson, CENAE-CO
Enclosures: Ice Jam Database Search Results

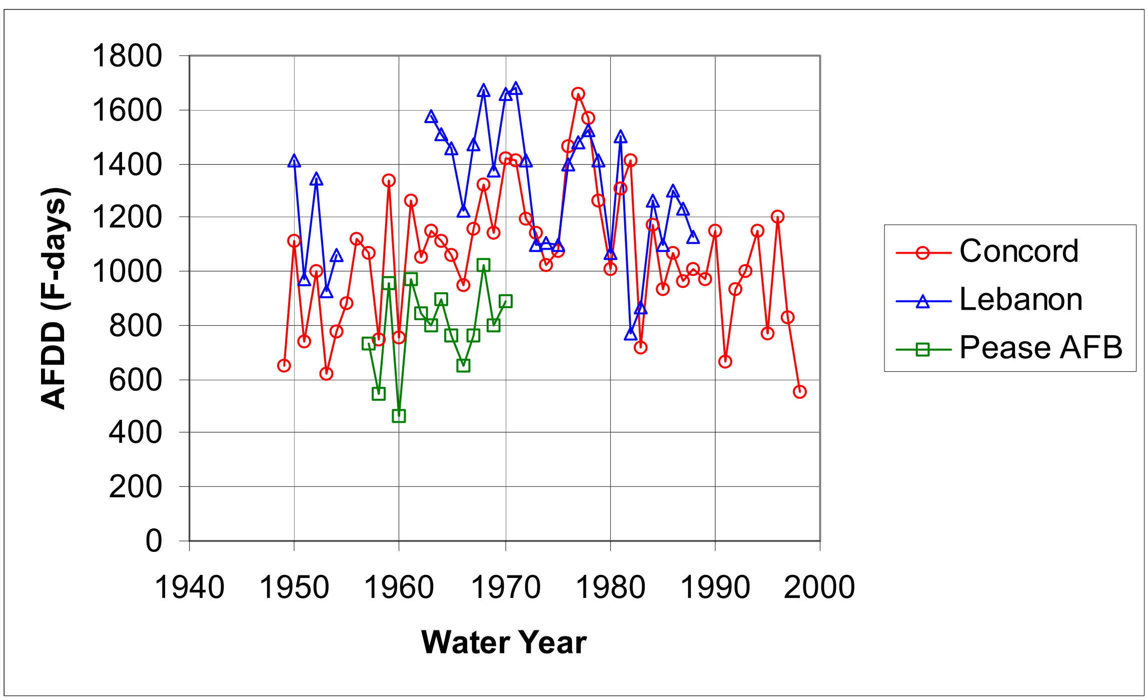

Figure 1. AFDD calculated from NWS data for three NH stations.

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